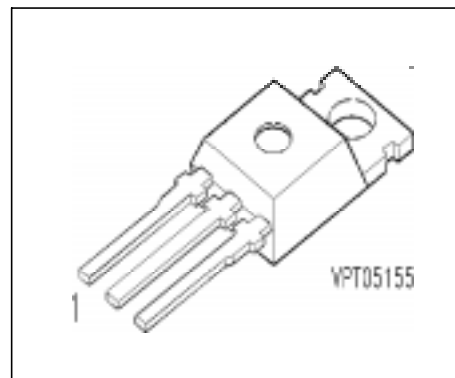


### IGBT With Antiparallel Diode

#### *Preliminary data*

- Low forward voltage drop
- High switching speed
- Low tail current
- Latch-up free
- Including fast free-wheel diode



| Pin 1 | Pin 2 | Pin 3 |
|-------|-------|-------|
| G     | C     | E     |

| Type     | $V_{CE}$ | $I_C$ | Package   | Ordering Code   |
|----------|----------|-------|-----------|-----------------|
| BUP 410D | 600V     | 13A   | TO-220 AB | Q67040-A4425-A2 |

#### Maximum Ratings

| Parameter                                             | Symbol      | Values        | Unit             |
|-------------------------------------------------------|-------------|---------------|------------------|
| Collector-emitter voltage                             | $V_{CE}$    | 600           | V                |
| Collector-gate voltage                                | $V_{CGR}$   | 600           |                  |
| $R_{GE} = 20 \text{ k}\Omega$<br>Gate-emitter voltage | $V_{GE}$    | $\pm 20$      |                  |
| DC collector current                                  | $I_C$       | 13            | A                |
| $T_C = 25 \text{ }^\circ\text{C}$                     |             | 8             |                  |
| $T_C = 90 \text{ }^\circ\text{C}$                     |             |               |                  |
| Pulsed collector current, $t_p = 1 \text{ ms}$        | $I_{Cpuls}$ | 26            |                  |
| $T_C = 25 \text{ }^\circ\text{C}$                     |             | 16            |                  |
| $T_C = 90 \text{ }^\circ\text{C}$                     |             |               |                  |
| Diode forward current                                 | $I_F$       | 11            |                  |
| $T_C = 90 \text{ }^\circ\text{C}$                     |             |               |                  |
| Pulsed diode current, $t_p = 1 \text{ ms}$            | $I_{Fpuls}$ | 72            |                  |
| $T_C = 25 \text{ }^\circ\text{C}$                     |             |               | W                |
| Power dissipation                                     | $P_{tot}$   | 50            |                  |
| $T_C = 25 \text{ }^\circ\text{C}$                     |             |               |                  |
| Chip or operating temperature                         | $T_j$       | -55 ... + 150 | $^\circ\text{C}$ |
| Storage temperature                                   | $T_{stg}$   | -55 ... + 150 |                  |

## Maximum Ratings

| Parameter                           | Symbol | Values        | Unit |
|-------------------------------------|--------|---------------|------|
| DIN humidity category, DIN 40 040   | -      | E             | -    |
| IEC climatic category, DIN IEC 68-1 | -      | 55 / 150 / 56 |      |

## Thermal Resistance

|                                     |             |            |     |
|-------------------------------------|-------------|------------|-----|
| Thermal resistance, chip case       | $R_{thJC}$  | $\leq 2.5$ | K/W |
| Diode thermal resistance, chip case | $R_{thJCD}$ | 3.1        |     |

## Electrical Characteristics, at $T_j = 25\text{ °C}$ , unless otherwise specified

| Parameter | Symbol | Values |      |      | Unit |
|-----------|--------|--------|------|------|------|
|           |        | min.   | typ. | max. |      |

## Static Characteristics

|                                                                                                         |               |     |     |     |               |
|---------------------------------------------------------------------------------------------------------|---------------|-----|-----|-----|---------------|
| Gate threshold voltage<br>$V_{GE} = V_{CE}, I_C = 0.35\text{ mA}, T_j = 25\text{ °C}$                   | $V_{GE(th)}$  | 4.5 | 5.5 | 6.5 | V             |
| Collector-emitter saturation voltage<br>$V_{GE} = 15\text{ V}, I_C = 6\text{ A}, T_j = 25\text{ °C}$    | $V_{CE(sat)}$ | -   | 2.1 | 2.7 |               |
| $V_{GE} = 15\text{ V}, I_C = 6\text{ A}, T_j = 125\text{ °C}$                                           |               | -   | 2.2 | 2.8 |               |
| $V_{GE} = 15\text{ V}, I_C = 12\text{ A}, T_j = 25\text{ °C}$                                           |               | -   | 3   | -   |               |
| $V_{GE} = 15\text{ V}, I_C = 12\text{ A}, T_j = 125\text{ °C}$                                          |               | -   | 3.3 | -   |               |
| Zero gate voltage collector current<br>$V_{CE} = 600\text{ V}, V_{GE} = 0\text{ V}, T_j = 25\text{ °C}$ | $I_{CES}$     | -   | -   | 80  | $\mu\text{A}$ |
| Gate-emitter leakage current<br>$V_{GE} = 25\text{ V}, V_{CE} = 0\text{ V}$                             | $I_{GES}$     | -   | -   | 100 | nA            |

## AC Characteristics

|                                                                                                        |           |   |     |     |    |
|--------------------------------------------------------------------------------------------------------|-----------|---|-----|-----|----|
| Transconductance<br>$V_{CE} = 20 \text{ V}$ , $I_C = 6 \text{ A}$                                      | $g_{fs}$  | 2 | -   | -   | S  |
| Input capacitance<br>$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$            | $C_{iss}$ | - | 320 | 430 | pF |
| Output capacitance<br>$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$           | $C_{oss}$ | - | 40  | 60  |    |
| Reverse transfer capacitance<br>$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$ | $C_{rss}$ | - | 25  | 40  |    |

## Electrical Characteristics, at $T_j = 25 \text{ }^\circ\text{C}$ , unless otherwise specified

| Parameter | Symbol | Values |      |      | Unit |
|-----------|--------|--------|------|------|------|
|           |        | min.   | typ. | max. |      |

## Switching Characteristics, Inductive Load at $T_j = 125 \text{ }^\circ\text{C}$

|                                                                                                                                      |              |   |     |     |    |
|--------------------------------------------------------------------------------------------------------------------------------------|--------------|---|-----|-----|----|
| Turn-on delay time<br>$V_{CC} = 300 \text{ V}$ , $V_{GE} = 15 \text{ V}$ , $I_C = 6 \text{ A}$<br>$R_{Gon} = 100 \text{ } \Omega$    | $t_{d(on)}$  | - | 20  | 35  | ns |
| Rise time<br>$V_{CC} = 300 \text{ V}$ , $V_{GE} = 15 \text{ V}$ , $I_C = 6 \text{ A}$<br>$R_{Gon} = 100 \text{ } \Omega$             | $t_r$        | - | 60  | 90  |    |
| Turn-off delay time<br>$V_{CC} = 300 \text{ V}$ , $V_{GE} = -15 \text{ V}$ , $I_C = 6 \text{ A}$<br>$R_{Goff} = 100 \text{ } \Omega$ | $t_{d(off)}$ | - | 175 | 240 |    |
| Fall time<br>$V_{CC} = 300 \text{ V}$ , $V_{GE} = -15 \text{ V}$ , $I_C = 6 \text{ A}$<br>$R_{Goff} = 100 \text{ } \Omega$           | $t_f$        | - | 160 | 220 |    |

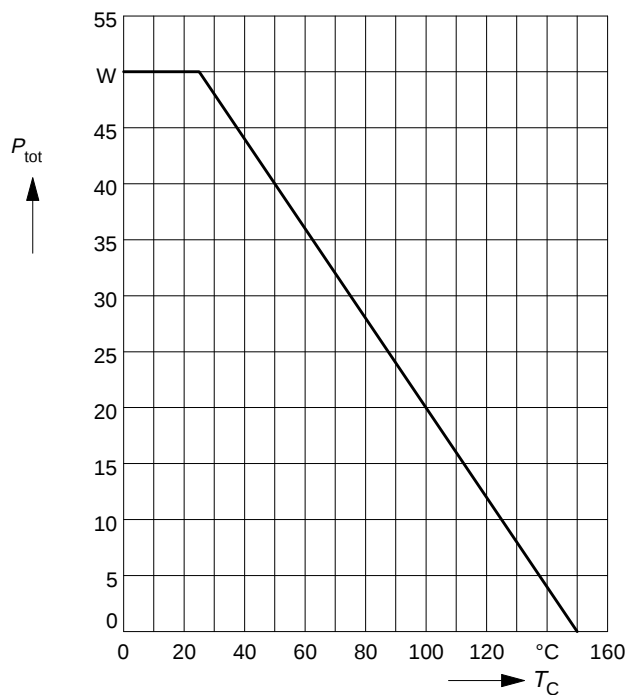
### Free-Wheel Diode

|                                                                                                                                                                                                |          |             |                |                 |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|----------------|-----------------|---------------|
| Diode forward voltage<br>$I_F = 10 \text{ A}$ , $V_{GE} = 0 \text{ V}$ , $T_j = 25 \text{ °C}$                                                                                                 | $V_F$    | -           | 1.65           | -               | V             |
| Reverse recovery time<br>$I_F = 10 \text{ A}$ , $V_R = -300 \text{ V}$ , $V_{GE} = 0 \text{ V}$<br>$di_F/dt = -100 \text{ A/}\mu\text{s}$<br>$T_j = 25 \text{ °C}$<br>$T_j = 125 \text{ °C}$   | $t_{rr}$ | -<br>-<br>- | -<br>60<br>100 | -<br>100<br>150 | ns            |
| Reverse recovery charge<br>$I_F = 10 \text{ A}$ , $V_R = -300 \text{ V}$ , $V_{GE} = 0 \text{ V}$<br>$di_F/dt = -100 \text{ A/}\mu\text{s}$<br>$T_j = 25 \text{ °C}$<br>$T_j = 125 \text{ °C}$ | $Q_{rr}$ | -<br>-      | 0.2<br>0.4     | 0.37<br>0.74    | $\mu\text{C}$ |

## Power dissipation

$$P_{\text{tot}} = f(T_C)$$

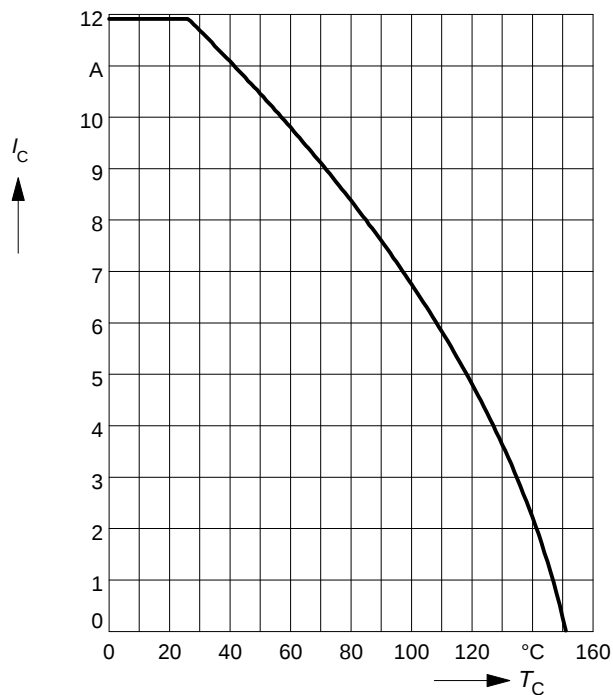
parameter:  $T_j \leq 150^\circ\text{C}$



## Collector current

$$I_C = f(T_C)$$

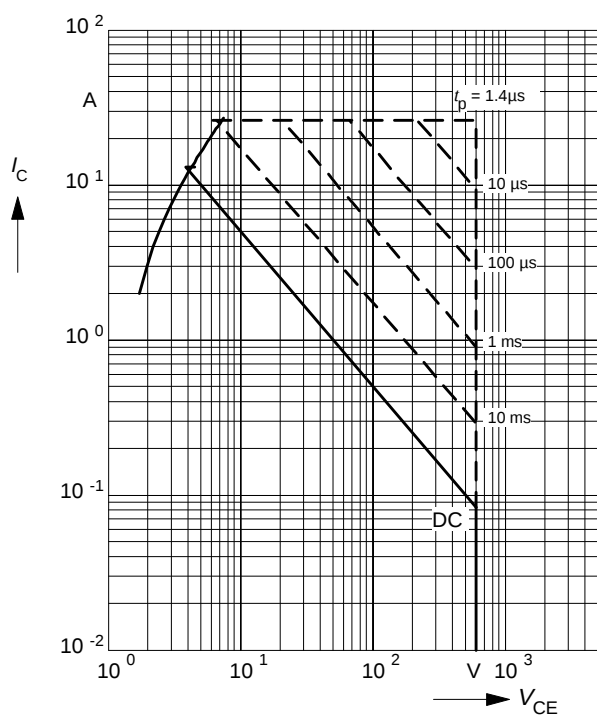
parameter:  $V_{\text{GE}} \geq 15\text{ V}$ ,  $T_j \leq 150^\circ\text{C}$



## Safe operating area

$$I_C = f(V_{\text{CE}})$$

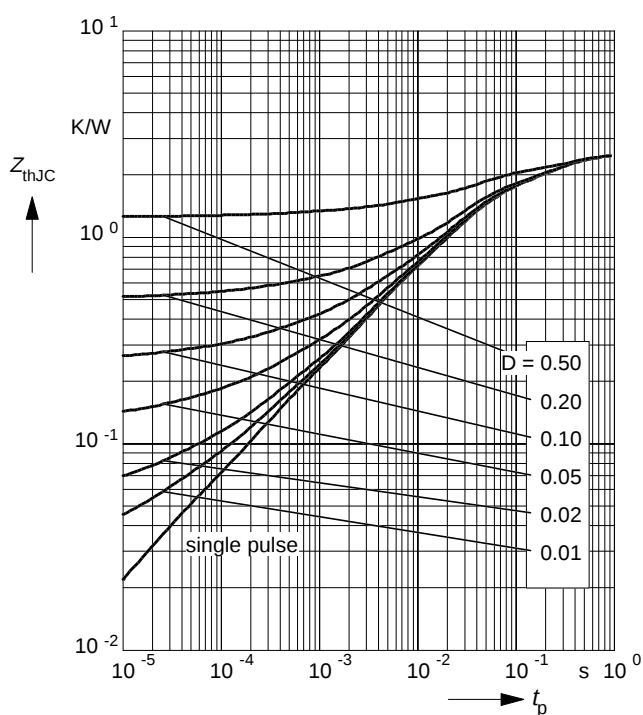
parameter:  $D = 0$ ,  $T_C = 25^\circ\text{C}$ ,  $T_j \leq 150^\circ\text{C}$



## Transient thermal impedance IGBT

$$Z_{\text{th JC}} = f(t_p)$$

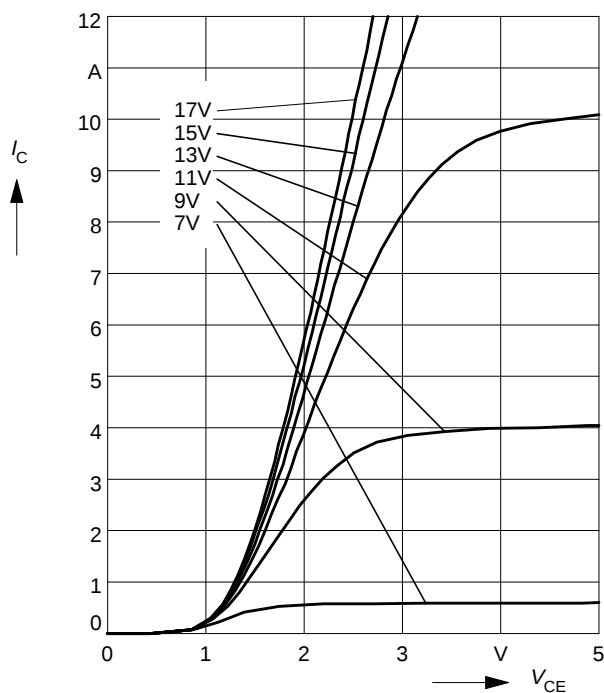
parameter:  $D = t_p / T$



## Typ. output characteristics

$$I_C = f(V_{CE})$$

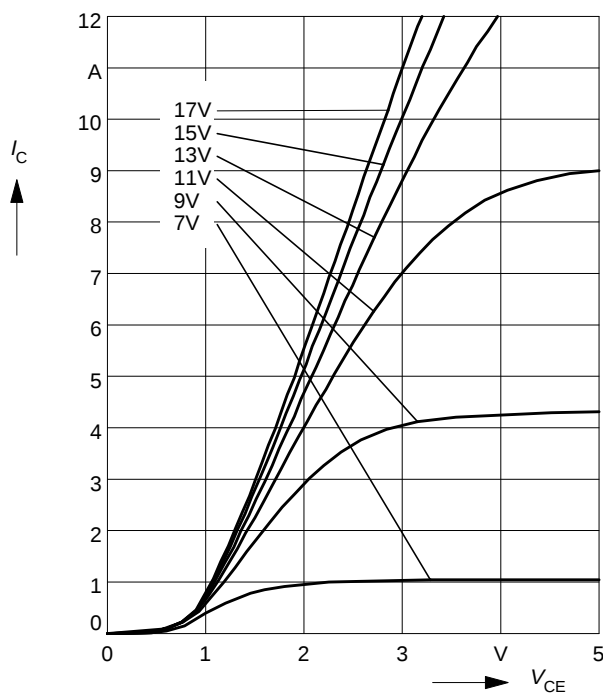
parameter:  $t_p = 80 \mu s$ ,  $T_j = 25^\circ C$



## Typ. output characteristics

$$I_C = f(V_{CE})$$

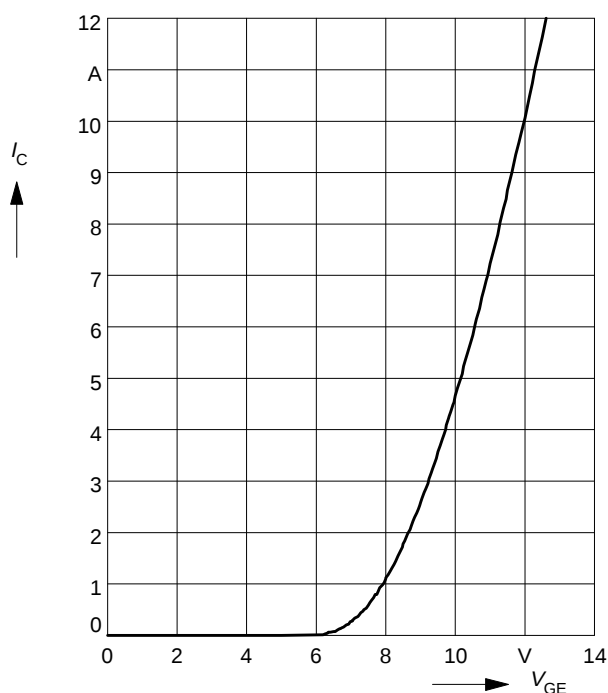
parameter:  $t_p = 80 \mu s$ ,  $T_j = 125^\circ C$



## Typ. transfer characteristics

$$I_C = f(V_{GE})$$

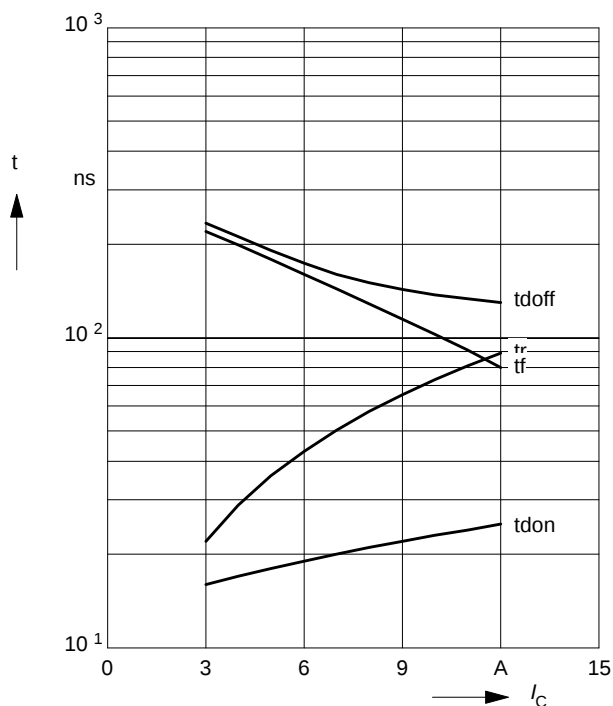
parameter:  $t_p = 80 \mu s$ ,  $V_{CE} = 20 V$



## Typ. switching time

$t = f(I_C)$ , inductive load,  $T_j = 125^\circ\text{C}$

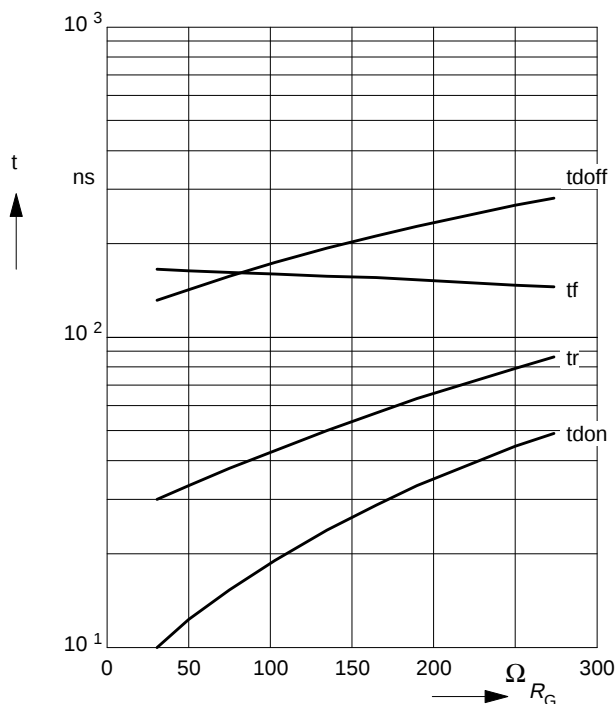
par.:  $V_{CE} = 300\text{ V}$ ,  $V_{GE} = \pm 15\text{ V}$ ,  $R_G = 100\ \Omega$



## Typ. switching time

$t = f(R_G)$ , inductive load,  $T_j = 125^\circ\text{C}$

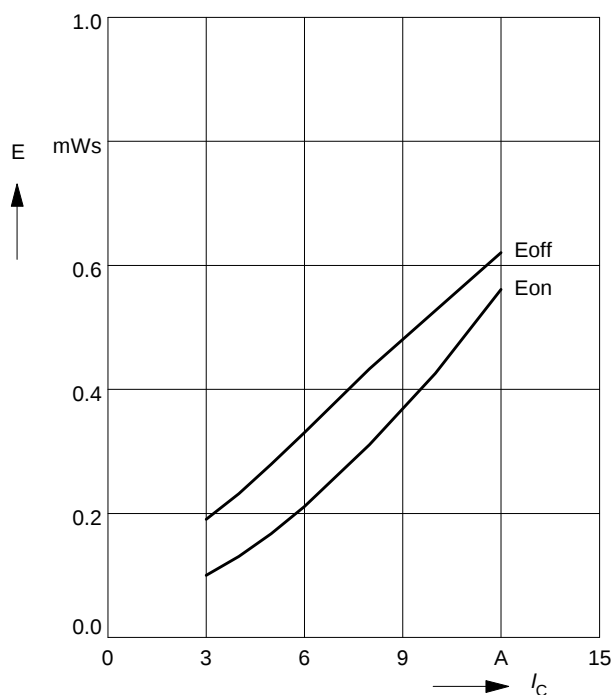
par.:  $V_{CE} = 300\text{ V}$ ,  $V_{GE} = \pm 15\text{ V}$ ,  $I_C = 6\text{ A}$



## Typ. switching losses

$E = f(I_C)$ , inductive load,  $T_j = 125^\circ\text{C}$

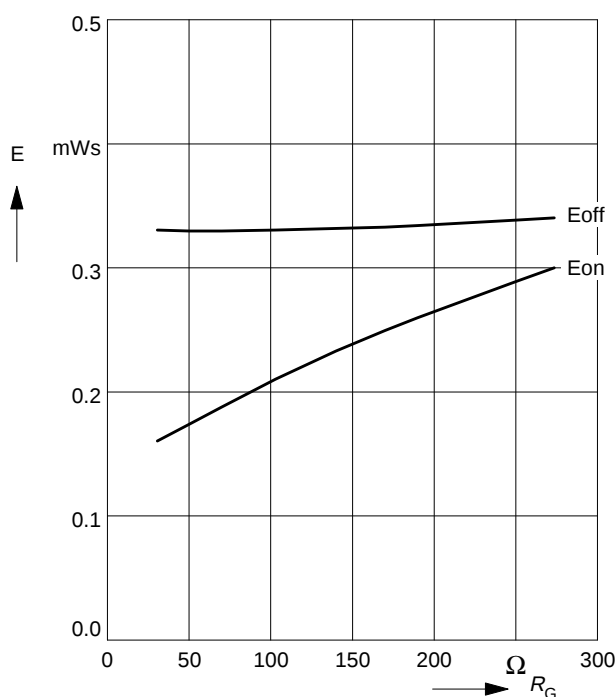
par.:  $V_{CE} = 300\text{ V}$ ,  $V_{GE} = \pm 15\text{ V}$ ,  $R_G = 100\ \Omega$



## Typ. switching losses

$E = f(R_G)$ , inductive load,  $T_j = 125^\circ\text{C}$

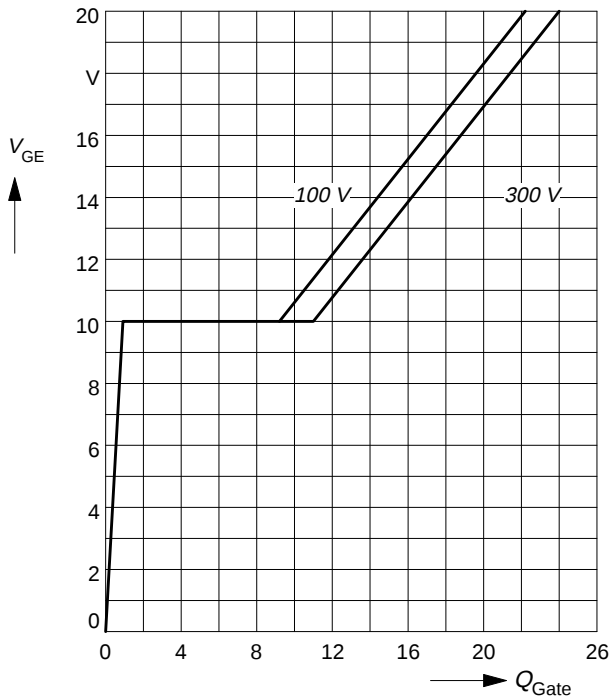
par.:  $V_{CE} = 300\text{ V}$ ,  $V_{GE} = \pm 15\text{ V}$ ,  $I_C = 6\text{ A}$



## Typ. gate charge

$$V_{GE} = f(Q_{Gate})$$

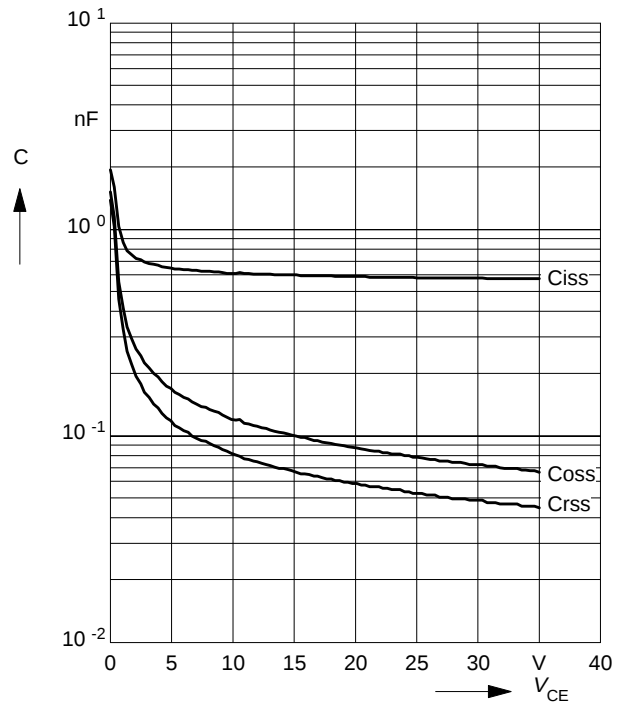
parameter:  $I_{C\ puls} = 6\ A$



## Typ. capacitances

$$C = f(V_{CE})$$

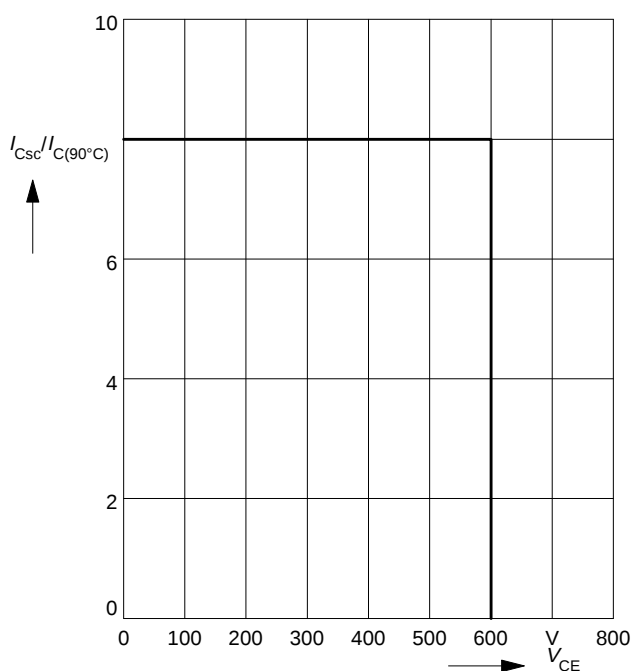
parameter:  $V_{GE} = 0\ V$ ,  $f = 1\ MHz$



## Short circuit safe operating area

$$I_{Csc} = f(V_{CE}), T_j = 150^\circ C$$

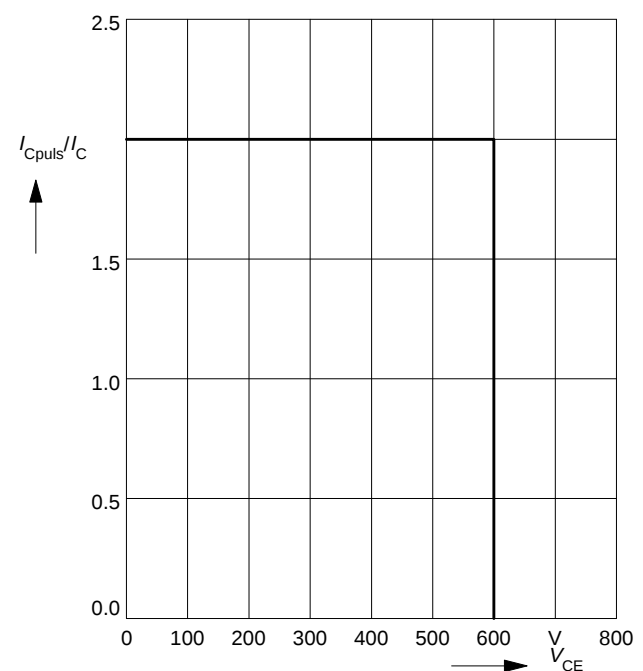
parameter:  $V_{GE} = \pm 15\ V$ ,  $t_{sc} \leq 10\ \mu s$ ,  $L < 50\ nH$



## Reverse biased safe operating area

$$I_{Cpuls} = f(V_{CE}), T_j = 150^\circ C$$

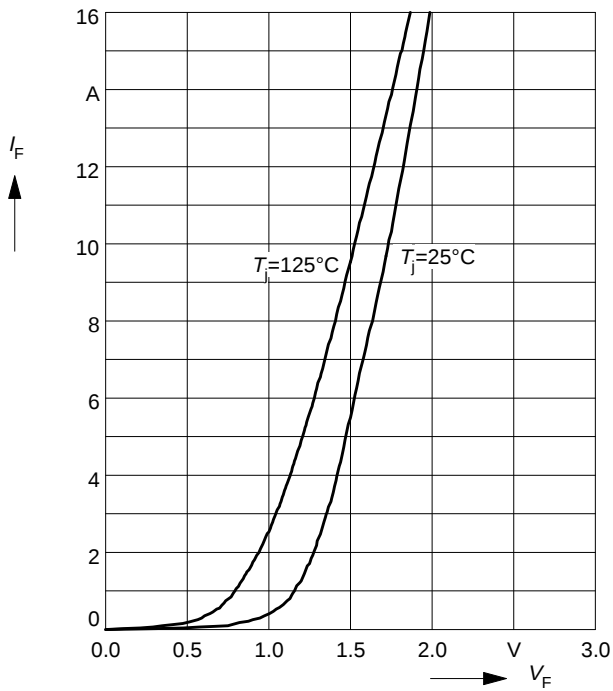
parameter:  $V_{GE} = 15\ V$



Typ. forward characteristics

$$I_F = f(V_F)$$

parameter:  $T_j$



Transient thermal impedance Diode

$$Z_{thJC} = f(t_p)$$

parameter:  $D = t_p / T$

